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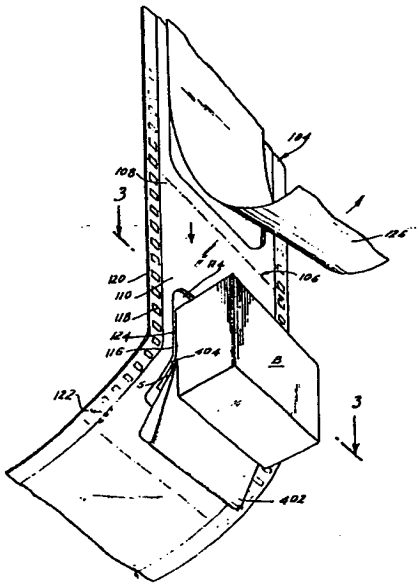
(54) Sectioning apparatus, section supporting device and method.

(57) A device for receiving and supporting a section cut from, for example, a biological specimen, comprises a spacer (108), such as a flexible protective layer, defining an aperture (114) of a dimension sufficient to receive a sample section (5), and a platen (124) having a surface of which at least a portion is adhesive and exposed through the aperture (114) for adherence to the block (B). The platen (124) is of material having elasticity sufficient to permit resilient extension of an adhesive portion of the surface through the aperture (114). The section-supporting device can form an integral part of the sectioning apparatus.



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SECTIONING APPARATUS, SECTION SUPPORTING DEVICE AND METHOD

The present invention is concerned generally with the sectioning of specimens, such as biological specimens, and in particular with a device for supporting a section and with apparatus for preparing a section.

To prepare a section of a biological specimen, such as a histological tissue specimen, for mounting upon a microscope slide, typically after fixation, dehydration and infiltration with melted paraffin, the specimen is embedded in a block of paraffin. Typically, sections are then cut from the embedded specimen by mounting the block of paraffin in the vice of a microtome, and relatively moving a cutting blade through the block, following small incremental advances of the block perpendicular to the cutting motion. The sections are then mounted upon a microscope slide(s) and stained. Apparatus and procedures for mounting tissues upon microscope slides are generally described in U.S. patent no. 2,996,762.

The use of adhesive tapes to hold biological specimen sections during sectioning is disclosed, for example. by Vannevar Bush, Science, 115:649-652 (1952). As in the reference by Bush, pressing a ribbon of cellulose tape against a section surface of paraffin block or frozen section of tissue sample to support a section cut from the block, is also disclosed by Palmgren, Nature, 174:40 (1954) (see also, Beckel, Nature, 184:1584 (1959) and Gowers et al, Nature, 190:424 (1961)).

U.S. Patent No, 3,690,988, discloses a microtome for sectioning biological specimens which comprises a knife and specimen holder movable relative to each other in a cutting stroke. A ribbon of tape having an adhesive surface is provided for collecting sequential sections from the specimen block. The tape extends from a supply roll to a collecting roll which holds the tape parallel to the direction of the cutting stroke (cutting plane). An advance mechanism moves the specimen holder in a direction perpendicular to the cutting plane to provide the thickness of the next section of the sample block to be cut. The tape is pressed against the sample block after each advance, but prior to the subsequent cutting stroke. During the cutting stroke, the tape is pressed against the exposed surface of the specimen block. The section cut from the specimen block adheres to the tape during the cutting of the section. The tape is advanced by a length substantially equal to the length of the cutting stroke between successive cutting operations. It is disclosed that the section being cut is backed and supported by the tape, so it will not be deformed or distorted (compressed) by the knife during the cutting process. This also is discussed in Collewijn et al, Stain Technology, 44:55 (1969).

We have found that inaccuracies and fouling of the microtome are both problems which plague apparatus such as described in the prior art. The clearances, or tolerances, required by the mechanical parts of the advance mechanism are shifted in one direction by activation of that mechanism and displaced, to the extent of the clearance, in the opposite direction by the pressure used in contacting the adhesive tape with the sample block. This pressure also changes the thickness of any lubricant film coating the mechanical parts. The thickness of the section then cut is thus made inaccurate by these deficiencies. The adhesive surface of the tape has also been observed to intermittently

contact and adhere to the side surfaces, or cutting facets, of the microtome blade, thus fouling the apparatus with resulting shut-down of operation.

We have now devised a section-supporting and an apparatus and method for sectioning a sample block, whereby the problems encountered in the prior art are reduced or overcome. The supporting device of the invention can form an integral part of the sectioning apparatus, which is particularly advantageous in the automated processing of tissue sections for clinical analysis, or it can be a single-use disposable device suitable for use with conventional apparatus, such as commercially available microtomes. In one aspect, the invention provides a device for supporting a section of a sample block comprising a spacer, such as a flexible protective layer, defining an aperture of a dimension sufficient to admit the section, and a platen having a surface of which at least a portion is adhesive and is exposed through the aperture. The platen is formed of a material having an elasticity sufficient to permit resilient extension of an adhesive portion of the surface through the aperture. The aperture of the protective layer can have a transverse dimension defined by the side wall, which is preferably greater than the thickness of the section of sample which is to be cut.

In one preferred embodiment, this protective layer is a film, such as a polymeric film, having an aperture cut or otherwise formed therein. The transverse dimension of the side wall is thus defined by the thickness of the particular film used. In a preferred embodiment, the platen comprises a polymeric film layer having an adhesive surface. In this embodiment, the film layer is preferably polyester and the adhesive is preferably pressure-sensitive adhesive. The device may further include a release backing for covering (before use) at least the adhesive exposed by the aperture of the flexible protective layer.

The device can take other forms particularly adapted for use in automated instruments. One such form is an elongated sheet of material having repeating segments, each of which comprises the structure as described above. For example, the elongated sheet of material can have a protective layer which comprises a film roll having uniform perforations along the length thereof and a platen which comprises a layer of polymeric film which has a pressure-sensitive adhesive on at least one side. The platen can further include means for positioning, such as sprocket holes.

In another aspect, the invention provides a sectioning apparatus having a blade for cutting a portion from a sample block and means for positioning a sample block relative to the blade. The apparatus also has a platen having a surface of which at least a portion is adhesive and means for positioning the platen surface relative to the sample block. Further, the apparatus includes means for relatively moving the adhesive portion of the platen surface and a cutting face of the sample block into mutual contact, means for relatively moving the sample block and the blade to cut a section of the sample block which adheres to the adhesive portion of the platen surface, and means for spacing that portion of the platen adhering to the sample section cut from said sample block during relative movement of the sample block and blade. In a preferred embodiment of this aspect of the invention, the means for spacing the platen from the sample block comprises a flexible protective layer defining an aperture of a dimension sufficient to admit said section and the platen has a surface of which at least a portion is adhesive. At least part of the adhesive portion is exposed by the aperture, and the platen is formed of a material having an elasticity sufficient to permit resilient extension through said aperture. A pressure roller mechanism

can be used for moving an adhesive portion of the platen surface and a portion of the sample block which are aligned with the cutting plane into mutual contact. The pressure roller mechanism can comprise: (a) a pressure roller; (b) a lever arm having opposed ends, one end being associated with the pressure roller; and (c) drive means, associated with the other end of the lever arm, for moving the pressure roller. In another embodiment, the pressure roller mechanism can comprise: (a) a pressure roller; (b) a racetrack cam, about which the pressure roller moves; and (c) drive means for moving the pressure roller.

In a further aspect, the invention provides a method of sectioning from the surface of a sample block, with a blade, which method comprises: (1) adhering a portion of a platen to the cutting surface of the sample block; (2) relatively moving the sample block and the blade to cut a section from the sample block; and (3) providing a spacer between the non-adhered portion of the platen and the blade to lift that portion of the section as it is being cut from the sample block during relative movement of the sample block and blade.

In order that the invention may be more fully understood, preferred embodiments thereof will now be described, by way of example only, with reference to the accompanying drawings, wherein:

FIGURE 1 is an isometric view of a preferred embodiment of a sectioning apparatus of the invention;

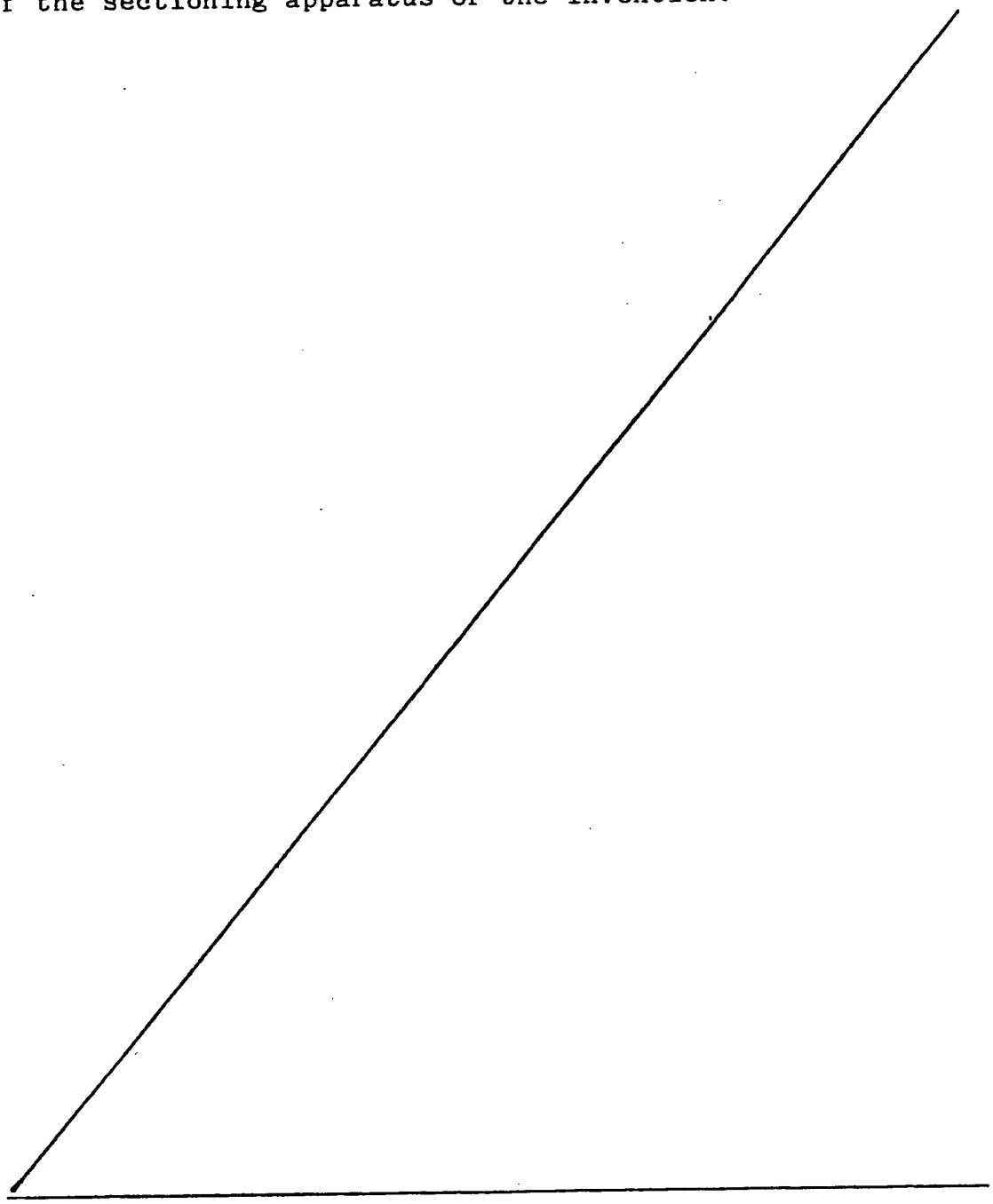
FIGURE 2 is a partial isometric view of a preferred embodiment of a sectioning apparatus of the invention, with emphasis on a preferred embodiment of the section-supporting device of the invention;

FIGURE 2a is a diagrammatic illustration of a section which is partially cut from a sample block and carried away by the section-supporting device of the invention;

FIGURE 3 is a cross-sectional view of the apparatus

and device illustrated in Figure 2, taken along line 3--3; and

FIGURES 4a-d are sequential diagrammatic views illustrating a cycle of operation of a preferred embodiment of the sectioning apparatus of the invention.



Although specific terms are used in the following description for clarity, they refer only to the particular embodiment(s) selected for illustration, and are not intended to limit the scope of the invention.

Referring now to Fig. 1, the section transfer apparatus, generally designated as 10, comprises a section-supporting device 102, a sample block mechanism 202, a pressure roller mechanism 302, a blade 402 and a series of spools and rollers arranged to feed and accept an elongated sheet 104 of section-supporting device 102 covered by a release backing 126.

Elongated sheet 104 is conveyed through section transfer apparatus 10 from supply spool 502 by identical drive sprockets 504a and 504b (1:1 gear ratio) which register with sprocket holes 118 along the side edges 120 of elongated sheet 104. Release backing 126 is stripped from elongated sheet 104 at stripping roller 508. The stripped backing is then fed to release backing take-up spool 510. Elongated sheet 104 is comprised of repeating segments 106, each of which is adapted to receive and support a section S of a sample from a sample block B. Repeating segments 106, each supporting a section S of the sample, pass in a slack loop onto elongated sheet take-up spool 516.

Sample block mechanism 202 holds sample block B in respect to the cutting plane defined by cutting edge 404 to the portion of elongated sheet 104 between tension roller 506 and cutting edge 404. The sample block B is held in chuck 208 by screw clamp 206. An advance mechanism (not illustrated)

moves sample block B along a path perpendicular to the cutting plane of the apparatus. The extent to which the sample block B is advanced defines the thickness of the section S of sample to be cut.

Pressure roller mechanism 302 moves against elongated sheet 104 opposing sample block B, thereby pressing adhesive surface 124 into contact with the portion of sample block B exposed above cutting edge 404. In the embodiment illustrated pressure roller mechanism 302 comprises: (a) a pressure roller 304; (b) a lever arm 306 having opposed ends, one end being associated with the pressure roller, e.g., rotatably mounted; and (c) drive means, such as solenoid 310, associated with the other end of lever arm 306. Solenoid 310 is responsive to a conventional operator activated drive means which is not illustrated. Frame mount 308 serves as a fulcrum for the action of lever arm 306 in moving roller 304 into contact with and away from elongated sheet 104. In another embodiment (not illustrated) the pressure roller mechanism comprises a roller which moves about the track of a racetrack cam. A racetrack cam is a closed loop track about which a cam, such as a roller, moves. During movement along one straightaway portion of the racetrack cam, the roller is in contact with and applies pressure to that portion of the elongated sheet which is in contact with the sample block.

Referring now to Fig. 2, section-supporting device 102 is shown in the form of an elongated sheet 104, with repeating segments 106 denoted by phantom lines. Elongated sheet 104 is illustrated in characteristic relationship to sample block B and blade 402 when used in a section transfer apparatus such as that of Fig. 1.

As shown, each repeating segment 106 comprises: (a) a flexible protective layer 108, having an external surface 110, an internal surface 112 and an aperture 114 therethrough, and (b) a platen 122 having a surface 124, of which at least a portion is adhesive, associated with internal surface 112 such that at least a portion of the adhesive is exposed through aperture 114. Aperture 114 is defined by aperture wall(s) 116 and is of dimensions sufficient to admit a section S of the sample. Platen 122 is of a material having elasticity sufficient to permit resilient extension of adhesive surface 124 beyond external surface 110 of flexible protective layer 108.

Platen 122 is illustrated to be a 0.0005 inch thick Mylar™ polyester film coated with a 0.0005 inch thick layer of pressure-sensitive adhesive. The adhesive-coated film is available from 3M Company, St. Paul, MN. Mylar™ is a trademark of E. I. duPont deNemours, Wilmington, DE. Other thin films having low stiffness, including flexible metals, can be used as can a wide variety of pressure-sensitive adhesives. In the embodiment illustrated, flexible protective layer 108 has a 0.004 inch thick Mylar polyester film. Other flexible films having a thickness of from about 0.001 to about 0.008 inch are also suitable. In another embodiment, not illustrated, the protective layer can be of a reuseable rigid material, such as inflexible sheet metal and is not bound to the platen.

Referring now to Fig. 2a, adhesive surface 124 of section-supporting device 102 is in contact with section S which has been partially cut from sample block B. Blade 402 is positioned adjacent to sample block B such that cutting edge 404 of blade 402 has cut a portion of transverse section S

from sample block B. The resiliency of platen 122 of section-supporting device 102 withdraws section S as the cut is made. The portion of section S which has been cut is drawn away from blade 402 and into aperture 114, which is bordered by side wall(s) 116. The section S of sample is spaced from blade 402 by protective layer 108, which is thicker than the transverse dimension of section S. Subsequent to cutting, platen 122 resumes its original position such that adhesive surface 124, supporting section S, is parallel to internal surface 112 of flexible protective layer 108.

Blade 402 has an upper cutting facet 406 and lower cutting facet 408 which converge at cutting edge 404. External surface 110 of flexible protective layer 108 rides on a portion of upper cutting facet 406, then moves or lifts off, deflecting that portion of section-supporting device 102 which has received a portion of section S into aperture 116. The angle α which is created between the side of blade 402 and external surface 110 is maximized. This angle is predetermined by defining the amount of slack, and thus the shape of the slack loop, between blade 402 and drive sprocket 504b (not shown). This acts in conjunction with the resiliency of platen 122 to further protect section S and insure uninterrupted operation of the sectioning apparatus. In this way the risk of contact between adhesive surface 124 and blade 402 is overcome.

Fig. 3 is a cross-section of Fig. 2 taken along line 3--3 and illustrates the elasticity of platen 122. The directional arrows depict the plane of movement of pressure roller 304 for contact of adhesive surface 124 with sample block B and subsequent withdrawal of roller 304. When in contact with and prior to cutting section S from the sample block B, platen 122

is extended through aperture 114 to contact sample block B. As shown, adhesive surface 124 remains in contact with sample block B even after roller 304 has withdrawn to its original position. The transverse dimension between internal surface 112 and external surface 110 is defined by the height of aperture wall(s) 116. This cross-section shows sprocket holes 118 parallel to side edges 120. The sample block mechanism 202 is shown in simplified form.

The sequential diagrammatic views of Figs. 4a-d illustrate a cycle of operation of section transfer apparatus 10. Referring to Fig. 4a, elongated sheet 104 is metered out from the supply spool (not shown) by drive sprocket 504a, a distance equivalent to the length of a repeating segment 106 to replenish the repeating segment used in the previous cycle. The supply spool provides a slight reverse drag against the metering by drive sprocket 504a to maintain registration of drive sprocket 504a with the sprocket holes of elongated sheet 104. Concurrently, drive sprocket 504b is metering an equivalent length of elongated sheet 104 onto the elongated sheet take-up spool (not shown) which provides a slight forward or take-up draw on the portion of elongated sheet 104 which is being fed to it by drive sprocket 504b to maintain registration of drive sprocket 504b with the sprocket holes of elongated sheet 104. An equivalent length of release backing 126 is also stripped concurrent with this metering of elongated sheet 104. During this portion of the operating cycle release brake 512, which is controlled by switch 513, is freely rotating with elongated sheet 104. Pressure roller 304 is not in contact with elongated sheet 104. Sample block B is at the bottom of the

cutting plane. Precise positioning of elongated sheet 104 is critical so that a repeating segment 106 is properly aligned to receive a section S of the sample. This positioning is achieved by the metered feed of elongated sheet 104 by drive sprockets 504a and 504b.

Referring now to Fig. 4b, a fresh repeating segment of elongated sheet 104 is registered with sample block B and release brake 512 is activated by switch 513 to momentarily fix elongated sheet 104 in position. Sample block B is positioned such that a portion thereof is above cutting edge 404. Pressure roller 304 is moved into contact with elongated sheet 104 by pressure roller mechanism 302. Concurrently, sample block mechanism 202 (shown in simplified form) begins to move sample block B up into contact with elongated sheet 104. Lamination of the exposed face of sample block B with the adhesive portion of the repeating segment which has been registered into position begins. This contact and upward motion creates a slack in elongated sheet 104 (shown in phantom). As soon as this adhesion is established, release brake 512 is disengaged from elongated sheet 104 by switch 513 and registration is thereafter maintained by the adhesive contact and by tension roller 506. The adhesive portion of elongated sheet 104 is pressed into contact with the remainder of the exposed face of sample block B by pressure roller 304 during upward movement of sample block B.

As shown in Fig. 4c, when the upward movement of sample block B has been completed, pressure roller 304 is withdrawn and release brake 512 is disengaged. An appropriate advance mechanism (not shown) advances sample block B (as indicated by

directional arrow) to the desired thickness increment perpendicular to the cutting plane in preparation for cutting of the section S of the sample. Thus, there is no force applied by pressure roller 304 when the cut takes place and the positional distortion caused by mechanical slack of the advance mechanism and thinning of advance mechanism lubrication films by the pressure of roller 304 have been relieved by the motion of the advance mechanism in the opposite direction.

Finally, in Fig. 4d, sample block mechanism 202 begins to move sample block B down (as indicated by the directional arrow) to commence the cutting cycle. The cutting edge 404 of blade 402 has begun cutting a section S from sample block B. Due to its resiliency, platen 122 draws, on a continuous basis, that portion of section S which has been cut into aperture 114 (see Fig. 2a) and away from blade 402, so as to prevent contact with facet 406 of blade 402. Thus, sample section S is physically lifted from the cutting plane and blade facet 406. Further, flexible protective layer 108 rides over blade facet 406 and positively prevents contact of the adhesive surface of platen 122 and facet 406 of blade 402. Also, it is evident that, even if elongated sheet 104 is not lifted from the surface of facet 406, the withdrawal of sample section S into aperture 114 would prevent contact with blade 402. The movement of sample block B, is sufficient to completely sever section S from the sample block B, which adheres to the adhesive portion 124 of platen 122. Elongated sheet 104 forms a slack loop between blade 402 and drive sprocket 504b. The amount of slack permitted is predetermined to lift flexible protective layer 108 off blade 402 which is also illustrated in Fig. 2a and described

above. This completes the operational cycle and drive sprockets 504a and 504b are activated to move elongated sheet 104 forward the length of another repeating segment 106 to initiate a subsequent operating cycle.

CLAIMS:

1. A device for supporting a section of sample block, which device comprises a spacer (108) defining an aperture (114) of a dimension sufficient to admit said section (5); and a platen (122) having a surface of which at least a portion is adhesive, at least part (124) of said adhesive portion being exposed through said aperture for adherence to said section, said platen being of a material having an elasticity sufficient to permit resilient extension of an adhesive portion of the surface through said aperture.

2. A device according to claim 1, wherein the spacer is a flexible protective layer which forms a laminate with the platen.

3. A device according to claim 1 or 2, wherein said platen comprises a polymeric film layer having an adhesive surface.

4. A device according to claim 3, wherein said platen comprises a polymeric film layer and adhesive layer of substantially the same dimensions in laminar relationship.

5. A device according to any of claims 1 to 4, which further comprises a release backing (126) covering at least the adhesive exposed by the aperture.

6. A device according to any preceding claim, wherein said spacer has means (118) for positioning said device.

7. A device having repeating severable segments, each segment being adapted to support a section of a block (B) of sample and comprising a flexible protective layer (108) defining an aperture (114) of a dimension sufficient to admit said section; and a platen (122) having a surface

of which at least a portion is adhesive, at least part (124) of said adhesive portion being exposed through the aperture for adherence to the block, the platen being of a material having elasticity sufficient to permit resilient extension of an adhesive portion of the surface through the aperture.

8. A device according to claim 7, wherein said flexible protective layer and said platen form a flexible laminate-(102).

9. A device according to claim 8, wherein a plurality of segments are formed in a continuous film roll having uniform perforations along the length thereof providing said apertures, and a layer of polymeric film which has a pressure-sensitive adhesive on at least one side providing said platens.

10. A sectioning apparatus comprising:

(a) a blade (402) for cutting a section (5) from a sample block (B);

(b) means (202) for positioning said sample block relative to said blade;

(c) a platen (122) having a surface of which at least a portion (124) is adhesive;

(d) means (512,513,202) for positioning the adhesive portion of the platen surface relative to the sample block;

(e) means (302) for relatively moving the adhesive portion of said platen surface and the sample block into mutual contact;

(f) means for relatively moving the sample block and the blade to cut a section of the sample block which is adhered to the adhesive portion of the platen surface; and

(g) means (108) for spacing from the blade that portion of

the platen adhering to the sample section cut from said sample block during relative movement of the sample block and blade.

11. Apparatus according to claim 10, wherein said means for spacing that portion of the platen adhering to the sample section cut from said sample block during relative movement of the sample block and blade comprises a spacer (108) defining an aperture (114) of a dimension sufficient to admit said section and said platen having a surface of which at least a portion is adhesive comprises a platen wherein at least part of said adhesive portion is exposed through said aperture for adherence to said block, and which is of a material having elasticity sufficient to permit resilient extension of an adhesive portion of the surface through said aperture.

12. Apparatus according to claim 10 or 11, wherein the means for moving an adhesive portion of the platen surface and a portion of the sample block which are aligned with the cutting plane into mutual contact is a pressure roller mechanism (302).

13. Apparatus according to claim 12, wherein the pressure roller mechanism comprising:

(a) a pressure roller (304);

(b) a lever arm (306) having opposed ends, one end being associated with the pressure roller; and

(c) drive means (310), associated with the other end of the lever arm, for moving the pressure roller.

14. Apparatus according to claim 12 wherein the pressure roller mechanism comprises:

(a) a pressure roller;

(b) a racetrack cam, about which the pressure roller moves; and

(c) drive means for moving the pressure roller.

15. Apparatus according to any of claims 10 to 14, wherein the platen surface of which at least a portion is adhesive is laminated with a release backing (126) which covers said adhesive prior to use.

16. Apparatus according to claim 15, which further comprises means (512) for separating said release backing from said platen.

17. Apparatus according to any of claims 10 to 16, which further comprises means for advancing said sample block a predetermined distance with respect to said adhesive surface of said platen.

18. Apparatus according to any of claims 10 to 17, which further comprises means for holding said platen in position relative to the sample block.

19. Apparatus according to any of claims 10 to 18, which further comprises means (504a,504b) for advancing said platen through said apparatus.

20. A method of sectioning from a surface of a sample block using a blade, which method comprises:

(1) adhering a portion of a platen to said surface of the sample block;

(2) relatively moving the sample block and the blade to cut a section from the sample block; and

(3) providing a spacer between the non-adhered portion of the platen and the blade to lift that portion of the section which has been cut from the sample block during relative movement of the sample block and blade.

FIG. 1

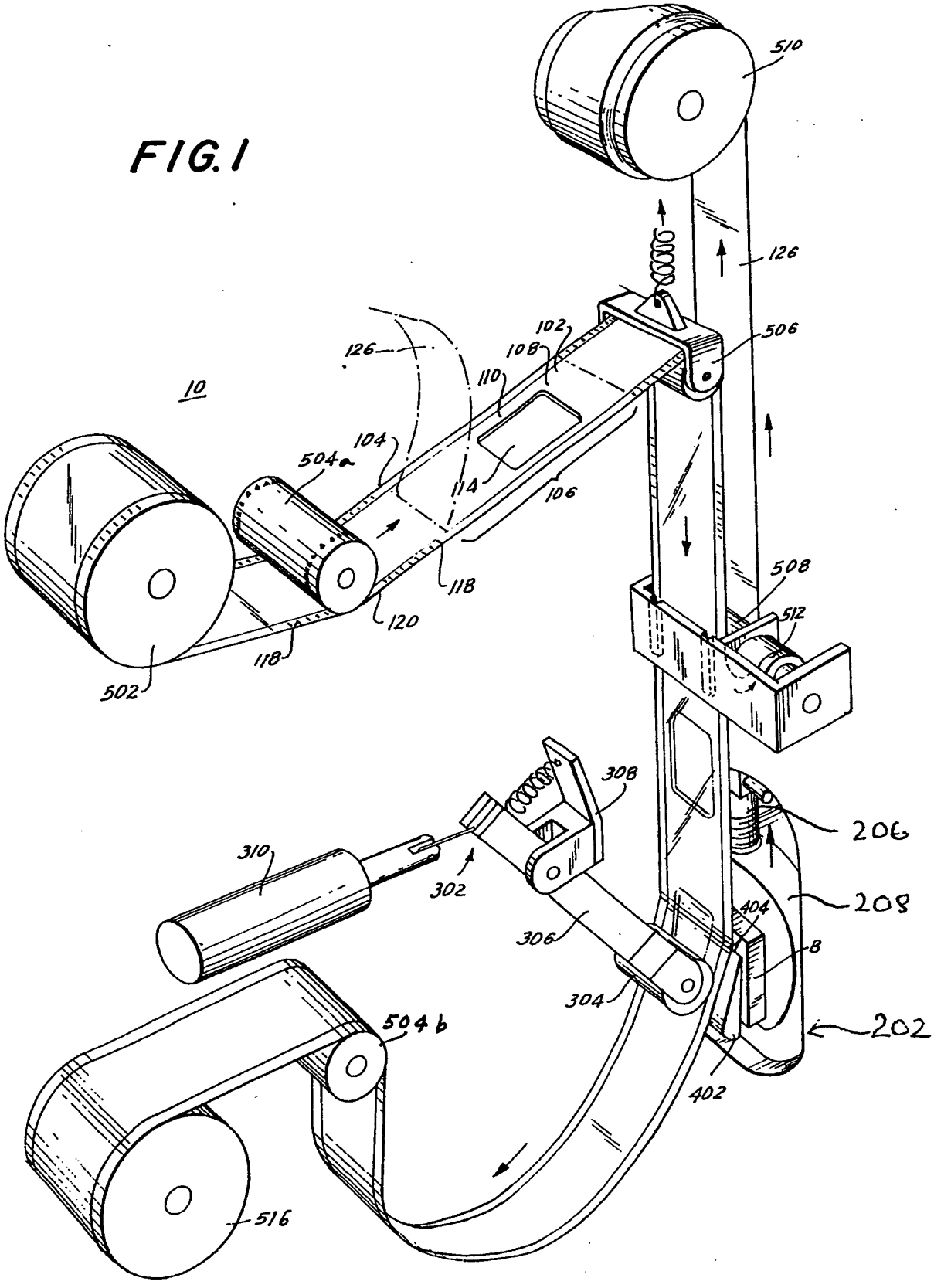
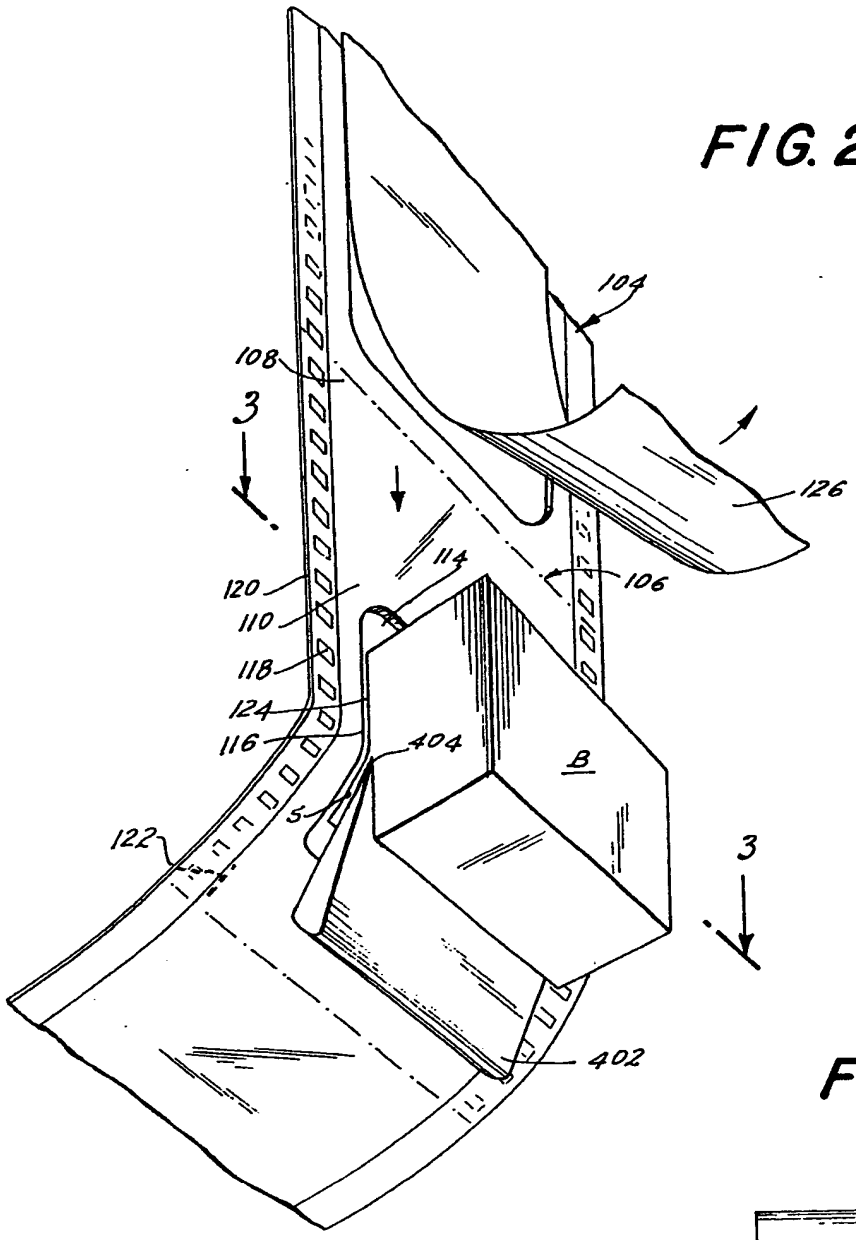

510
126
506
102
108
126
110
10
104
504a
114
106
118
120
118
502
508
512
308
206
310
302
208
306
404
8
304
504b
202
402
516

FIG. 2


104
108
3
126
114
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120
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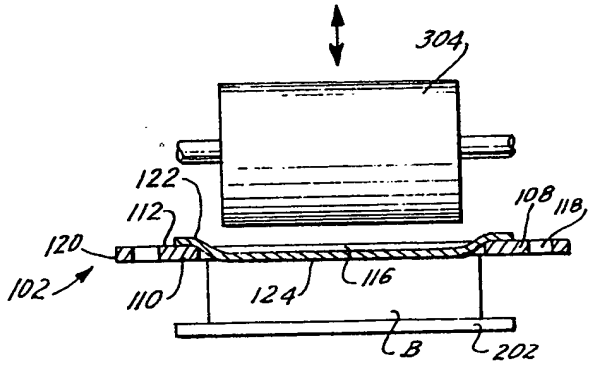
124
116
404
B
5
122
3
402

FIG. 3


304
122
112
108
118
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102
110
124
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B
202

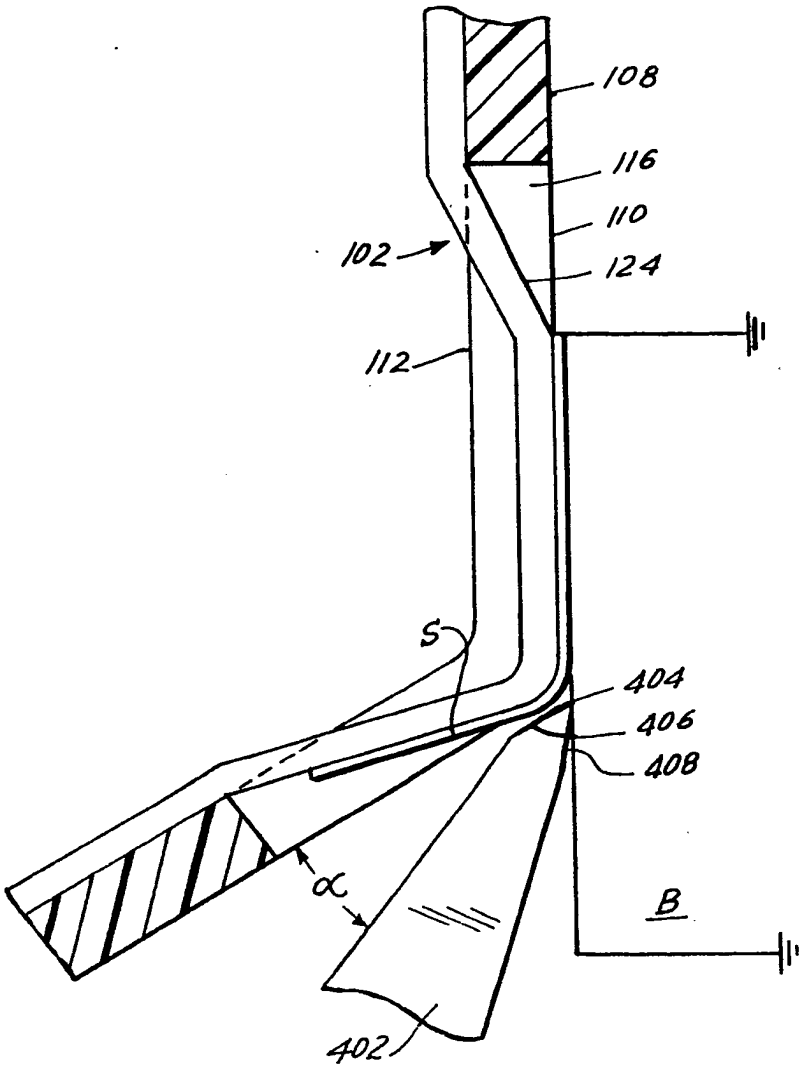


FIG. 2a

FIG. 4a

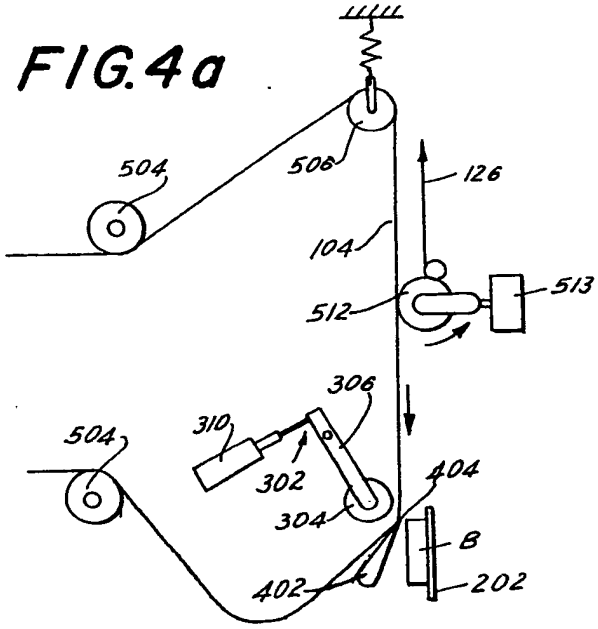


FIG. 4b

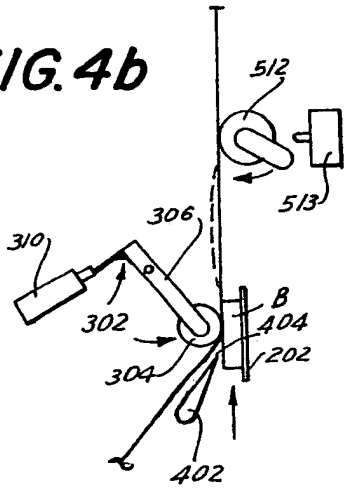


FIG. 4c

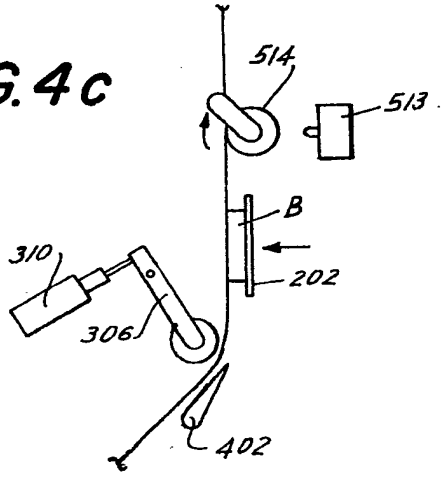
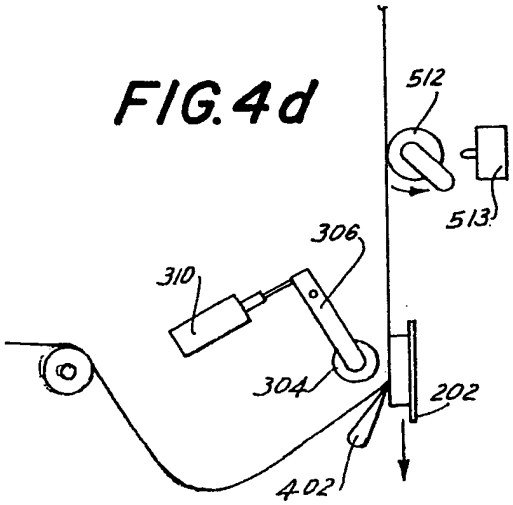


FIG. 4d



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Application number

EP 83 30 0881

European Patent Office

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
A	DE-A-2 412 315 (R. BURKHARDT)		G 01 N 1/06
A	US-A-3 924 500 (E.L. KINDEL)		
A,D	US-A-3 690 988 (S.G.F. ULLBERG)		
A	GB-A-1 240 548 (R.L. BISHTON)		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

G 01 N 1/06

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	19-05-1983	SCHWARTZ K

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document